

WHAT IS CLAIMED IS:

- 1 1. A method of cooling a target tissue region inside a body, the method
2 comprising:
3 providing fluid cooled below normal body temperature and blood at a normal
4 body temperature to the tissue region in proportions to cool the tissue region and
5 maintain, for an extended period of time, the temperature of the tissue region within
6 a target temperature range that is below normal body temperature.
- 1 2. The method of claim 1 wherein the cooled fluid and the blood at normal body
2 temperature are provided to the tissue region simultaneously.
- 1 3. The method of claim 1 wherein the providing of the blood at normal body
2 temperature to the tissue region is performed using a catheter that occludes a vessel
3 upstream from the tissue region and permits a selected amount of blood to flow
4 through a lumen in the catheter and to the tissue region.
- 1 4. The method of claim 3 wherein the catheter also performs the providing of
2 cool fluid to the tissue region.
- 1 5. The method of claim 1 wherein the providing of blood to the tissue region is
2 performed by occluding a vessel upstream from the tissue region to restrict normal
3 blood flow and then removing the occlusion to permit normal blood flow.
- 1 6. The method of claim 1 wherein a catheter provides blood to the tissue region
2 by partially occluding a vessel in fluid communication with the tissue region to permit
3 a restricted amount of blood to flow to the tissue region.

1 7. The method of claim 1 wherein a catheter positioned in a vessel in fluid
2 communication with the tissue region provides the fluid to the tissue region through a
3 lumen that extends longitudinally through the catheter, the lumen having a diameter
4 of at least twenty thousandths of an inch.

1 8. The method of claim 1 wherein the temperature of the tissue region is
2 maintained within the target temperature range that is below normal body
3 temperature for a time period beyond the normal length of time a tissue region is
4 deprived of oxygenated blood during a heart procedure.

1 9. The method of claim 8 wherein the normal length of time a tissue region is
2 deprived of oxygenated blood during a heart procedure is about two minutes.

1 10. The method of claim 1 wherein the temperature of the tissue region is
2 maintained within the target temperature range for at least about two minutes.

1 11. The method of claim 1 wherein the temperature of the tissue region is
2 maintained within a target temperature range of about 28 to 36 degrees Celsius.

1 12. The method of claim 1 wherein the providing of fluid and blood to cool the
2 target tissue region is performed during a procedure to open a lesion in a vessel.

1 13. The method of claim 1 wherein a control system controls the providing of fluid
2 and blood to the tissue region.

1 14. A method of cooling a target tissue region inside a body, the method
2 comprising:

3 occluding a body vessel to prevent normal blood flow to the tissue region;
 4 providing, while the body vessel is occluded, cooled fluid to the tissue region
 5 to cool the tissue region below normal body temperature;
 6 recommencing normal blood flow to the tissue region by removing the
 7 occlusion in the body vessel;
 8 preventing normal blood flow to the tissue region again by occluding the body
 9 vessel before the temperature of the tissue region returns to normal body
 10 temperature; and
 11 providing, while the body vessel is occluded, cooled fluid to the tissue region
 12 again to maintain the temperature of the tissue region below normal body
 13 temperature.

1 15. The method of claim 14 wherein the body vessel is occluded to prevent
 2 normal blood flow to the tissue region by inflating a balloon positioned in the vessel.

1 16. The method of claim 14 wherein a catheter positioned in a vessel at a location
 2 upstream from the tissue region provides the fluid to the tissue region through a
 3 lumen extending longitudinally through the catheter, the lumen having a diameter of
 4 at least twenty thousandths of an inch.

1 17. The method of claim 14 wherein a control system controls the occluding of
 2 the body vessel and the providing of cooled fluid to the tissue region to maintain the
 3 temperature of the tissue region below normal body temperature.

1 18. A method of cooling a target tissue region inside a body, the method
 2 comprising:

3 restricting normal blood flow to the tissue region so that only a desired
 4 amount of blood is provided to the tissue region; and
 5 providing cool fluid to mix with the blood provided to the tissue region so as to
 6 cool the tissue region below normal body temperature and to maintain, for an
 7 extended period of time, the temperature of the tissue region within a target tissue
 8 range that is below normal body temperature.

1 19. The method of claim 18 wherein the providing of the blood at normal body
 2 temperature to the tissue region is performed using a catheter that occludes a vessel
 3 upstream from the tissue region and permits a selected amount of blood to flow
 4 through a lumen in the catheter and to the tissue region.

1 20. The method of claim 18 wherein the providing of blood at normal body
 2 temperature to the tissue region is performed using a catheter to partially occlude a
 3 vessel upstream from the tissue region and permit a selected amount of blood to
 4 reach the tissue region.

1 21. The method of claim 18 wherein the temperature of the tissue region is
 2 maintained within the target temperature range that is below normal body
 3 temperature for a time period beyond the normal length of time a tissue region is
 4 deprived of oxygenated blood during a heart procedure.

1 22. The method of claim 21 wherein the normal length of time a tissue region is
 2 deprived of oxygenated blood during a heart procedure is about two minutes.

1 23. The method of claim 18 wherein the temperature of the tissue region is
2 maintained within the target temperature range for at least about two minutes.

1 24. The method of claim 18 wherein a catheter positioned in a vessel in fluid
2 communication with the tissue region provides the fluid to the tissue region through a
3 lumen that extends longitudinally through the catheter, the lumen having a diameter
4 of at least twenty thousandths of an inch.

1 25. The method of claim 18 wherein a control system controls the providing of
2 fluid to the tissue region to maintain the temperature of the tissue region below
3 normal body temperature.

1 26. A system for controlling the temperature of a target tissue region inside the
2 body, the system comprising:

3 a catheter for providing cooled fluid to the tissue region and for controlling
4 normal blood flow to the tissue region; and

5 a control system that controls the amount of the cooled fluid and blood that
6 the catheter provides to the tissue region so as to cool and to maintain, for an
7 extended period of time, the tissue region within a target temperature range that is
8 below normal body temperature.

1 27. The system of claim 26 wherein the catheter for providing fluid and controlling
2 normal blood flow to the tissue region is a perfusion catheter.

1 28. The system of claim 26 wherein the catheter for providing fluid and controlling
2 normal blood flow to the tissue region is a balloon catheter.

1 29. The system of claim 26 wherein the catheter comprises an infusion lumen for
2 providing fluid to the tissue region, the infusion lumen having a diameter of at least
3 twenty thousandths of an inch.

1 30. The system of claim 26 wherein the control system comprises a controller that
2 controls the cooling of the tissue region without measuring the temperature of the
3 tissue region.

1 31. The system of claim 26 wherein the control system comprises a controller that
2 controls the cooling of the tissue region without measuring the temperature of the
3 cool fluid as it exits the catheter and is provided to the tissue region.

1 32. The system of claim 26 wherein the catheter includes a temperature sensor
2 that may be advanced to a location distal to the catheter to measure the temperature
3 of the tissue region.

1 33. The system of claim 32 wherein the control system comprises a temperature
2 monitor that receives temperature information from the temperature sensor.

1 34. The system of claim 26 wherein the control system comprises an infusion
2 pump to control the amount of cool fluid provided to the tissue region.

1 35. The system of claim 26 wherein the control system comprises an inflation
2 pump to inflate and deflate a balloon on the catheter, the balloon controlling the
3 amount of blood provided to the tissue region.

1 36. A catheter for providing cool fluid to a tissue region inside a body, the catheter
2 comprising:

3 an elongated member having a lumen extending longitudinally therethrough
4 to a distal end of the elongated member; and

5 a temperature sensor that extends to a location distal to the distal end of the
6 elongated member to sense the temperature of the tissue region.

1 37. The catheter of claim 36 wherein the temperature sensor is a thermocouple.

1 38. The catheter of claim 37 wherein the thermocouple comprises two conductors
2 of different material extending from a proximal end of the catheter and joined at a
3 distal end to form a junction.

1 39. The catheter of claim 36 wherein the temperature sensor senses the
2 temperature of the tissue region by measuring the temperature of a vessel wall
3 located distal to the distal end of the elongated member and adjacent to the target
4 tissue region.

1 40. The catheter of claim 36 wherein the temperature sensor senses the
2 temperature of the tissue region by measuring the temperature of the cool fluid
3 provided to the tissue region distal to the distal end of the elongated member and
4 adjacent to the target tissue region.